A STUDY OF STUDENT PILOT ATTITUDES AND BEHAVIORS

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Initial flight training is a key phase in an airline pilot's career where safety attitudes are shaped. This paper presents the results of self-reported attitudes and behaviors among student- and instructor-pilots in the flight-training environment. A safety attitudes questionnaire was used to measure attitudinal differences and a safety behaviors questionnaire was used to measure behavioral differences. The safety attitudes survey measured responses across five factors: communication, stress management, power distance, safety culture, and vulnerability. The behaviors questionnaire measured responses across five behavioral expectations regarding preflight planning, awareness of self-limitations, technical confidence, assertiveness, and compliance with standard operating procedures. This study serves as the baseline in a longitudinal monitoring of safety attitudes and behaviors in flight training environment.

Introduction

The Human Factors Research Team at the University of Texas at Austin has done extensive research in the area of Crew Resource Management. Most recently, they have used a protocol called Line Oriented Safety Audit (LOSA) (Helmreich, In Press; Sexton & Klinect, In Press; and Helmreich, Klinect, & Wilhelm, In Press). The basic premise of the LOSA research has been to observe the normal behavior of pilots during their routine operation of scheduled airline flights. These observations were recorded by trained observers in accordance with a protocol developed by the University of Texas research team, called the LOSA Observation Protocol. According to this protocol, "threats" are events that may pose a potential danger to flight safety. Helmreich and his team claim that although the research observations should not be generalized to all the airlines (because of significant differences among the different airlines), they can be used as longitudinal measures to study the ability of the flight crews to manage threats. Helmreich and his team discovered that some airlines encountered more threats than others and some crews managed threats better than others.

Prior to the LOSA research, Helmreich and his team developed a safety attitudes questionnaire, called CMAQ (Helmreich, et al., 1986) which has been used extensively in Crew Resource Management research and subsequently modified by Taylor (1995) to research the safety attitudes among aircraft mechanics. Additionally, Ciavarelli and Figlock (1997) developed an organizational safety culture questionnaire that has been used in a variety of industries including nuclear science, off-shore oil platforms, and naval aviation. Recently, Ciavarelli and Figlock's survey has been adopted by Embry-Riddle Aeronautical University to study safety culture among university-level aviation students.

The research team in the Aviation Safety Management program at Saint Louis University created a Flight Instruction Safety Culture Questionnaire (FISCQ) to measure the safety attitudes and the Flight Instructor/Student Safety Behavior Questionnaire (FISSBQ) to measure the safety behaviors among flight students enrolled in schools that are certified under either the Code of Federal Regulations § 61 or § 141. The FISCQ is based on works by Helmreich, Taylor, and Ciavarelli and Figlock, as reported earlier. Most of the questions have been reworded to suit the flight training environment and some of the questions are new. All the items in the FISSBQ are new.

Methodology

Description of the Population and the Sample

Flight instruction can be conducted either in accordance with the Code of Federal Regulations (14CFR) § 61 or § 141. In the state of Missouri, there are 85 flight-training organizations (also called flight schools): seven of them are listed as 14 CFR § 141 organizations and the rest are 14 CFR § 61 organizations. The disproportionately large number of organizations operating under § 61 is consistent with the national average. All 85 organizations were invited to participate in this research. However, only 28 flight schools volunteered. Since there are about 1200 pilots actively engaged in flight instruction (including students and instructors) at these schools, the requisite sample size was determined to be 291 (Gay, 1996, p. 125).

The FISCQ Instrument

The Flight Instruction Safety Culture Questionnaire was developed using the Cockpit Management Attitudes Questionnaire (Helmreich, et al., 1986), the

Maintenance Resource Management/Technical Operations Questionnaire (Taylor, 1995), and Ciavarelli and Figlock's (1997) organizational safety culture assessment questionnaire. Items from these three questionnaires were selected based on their applicability to the flight instruction environment. Additionally, items regarding organizational attachment were added. Ultimately, the FISCQ consisted of 62 items on a five-point scale. The questionnaire was expected to measure safety attitudes and safety culture parameters.

The FISSBQ Instrument

The Flight Instructor/Student Safety Behavior Questionnaire was developed at Saint Louis University. It was administered in this study for the first time. It consisted of 40 items on a five-point scale. These items consist of 26 generic items related to anticipated pilot behaviors and the remaining 14 items were based on the subject flight school's procedural requirements.

Survey Administration

A total of 1200 FISCQ questionnaires were sent to the 28 flight schools that volunteered to participate in this study. Each respondent was provided with a postage-paid envelope in which to return the questionnaire.

Only one flight school volunteered to participate in the behavior (FISSBQ) study. Fifty subjects were surveyed at that site.

Results

Description of Samples

A total of 122 responses to the FISCQ were received. The distribution of this sample was as follows: 36.9% student pilots, 31.1% private pilots, 13.9% commercial pilots, and 18.0% certified flight instructors. The difference among these groups was significant, χ^2 (3, N=122) = 17.08, p = 0.001. In terms of flight school certification, 30.3% of the respondents were from § 61 schools, 62.3% were from § 141 schools, and the rest did not declare their affiliation.

A total of 44 responses to the FISSBQ were received. The distribution of this sample was as follows: 6.8% student pilots, 68.2% private pilots, 20.5% commercial pilots, and 4.5% certified flight instructors. All these responses were from one school.

Since the available sample size does not meet the minimum requirements for the findings to be applicable to the target population, the findings reported in this study should be considered preliminary, not applicable to the flight students in the entire state of Missouri.

Analyses of the attitude survey, the FISCQ Instrument

A factor analysis was performed on the responses (N=122) to the FISCQ. The initial factor analysis using the first 28 attitude-related items resulted in a Kaiser-Meyer-Olkin (KMO) measure of 0.613, Bartlett's test of sphericity was significant ($p < 0.000$). Since the computed KMO measure of sampling adequacy was less than the required 0.70 (Morgan & Griego, p 117), 11 items were iteratively removed from the factor analysis until the KMO measure of .712 was obtained, Bartlett's test continued to be significant ($p < 0.000$). Subsequently, five components were extracted which together accounted for 58% of the variance.

Based on the items contained in each of the five components, they were labeled as follows: communication, stress management, power distance, professionalism, and vulnerability. The first three components in the above list are consistent with previous research in Crew Resource Management (Helmreich & Merritt, 1998; Helmreich, et al., 1986, and Helmreich, et al., In Press), and the first four components are consistent with previous research in Maintenance Resource Management (Taylor, 1995, Taylor & Patankar, 1999, and Taylor & Thomas, In Press). The fifth component, vulnerability, is being reported for the first time.

A similar factor analysis process on the safety culture items (29 through 62) did not yield a positive definite matrix because the sample size was not adequate for factor analysis. Nonetheless, principal component extraction and varimax rotation identified five components. The top three components were chosen because it was believed that with a larger sample size, these components were likely to remain stable. These three components were labeled as follows: organizational image, quality, and internal communication processes.

Given the facts that the sample size was limited and this was the first time such questionnaires were administered in the flight-training environment, item-wise analysis of variance (ANOVA) was conducted across the four different pilot groups to identify items that had significant differences. A similar process

was used to identify significant differences across the types of flight-training organizations.

Comparison across pilot groups. A one-way ANOVA on each component of the five components communication, stress management, power distance, professionalism, and vulnerability, did not indicate a significant difference across the four pilot groups, $p > .05$.

An item-wise one-way ANOVA across the four pilot groups revealed significant differences ($p < 0.05$) between groups for three items. Table 1 lists these items. Figures 1-3 illustrate the respective scores on a 5-point scale.

Table 1: Table of items with significant differences across pilot groups.

Item Number	Description
11	I am ashamed when I make a mistake in front of my instructor or my peers.
18	The pilot receiving instruction should verbalize plans for procedures or maneuvers and should be sure that the information is understood and acknowledged by the instructor.
36	Safety in this organization is largely due to positive changes resulting from our past experience with incidents and/or accidents.

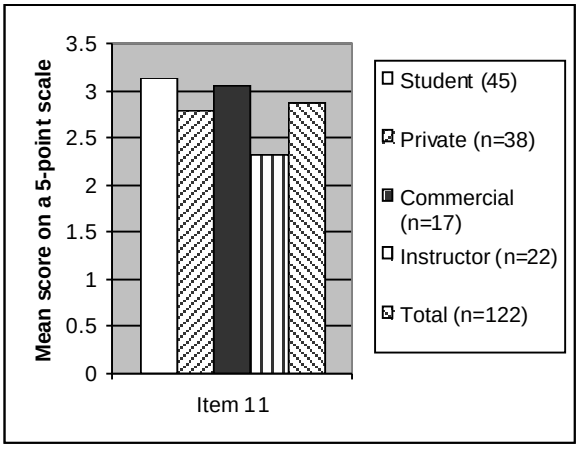

Figure 1: Level of agreement with item 11. Only the difference in agreement between the student and instructor groups is significant.

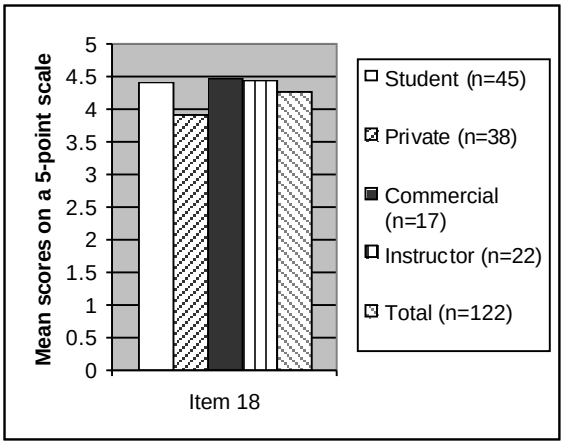

Figure 2: Level of agreement with item 18. Only the differences in agreement between the student and private pilots and private and commercial pilots are significant.

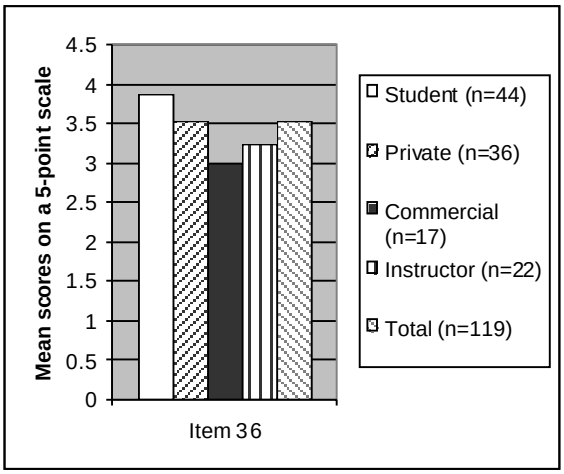

Figure 3: Level of agreement with item 36. Only the difference in agreement between the student and commercial pilots is significant.

Comparison across flight-training organizations. An independent samples t-test was conducted over a sample consisting of all subjects belonging to § 61 organizations and another sample consisting of all subjects belonging to § 141 organizations. This analysis indicated that there was no statistically significant difference between these two groups ($p > .05$) among the five components: communication, stress management, power distance, professionalism, and vulnerability.

An item-wise comparison between the two types of organizations revealed significant differences for six items (see Figures 4), $p < 0.05$. Table 2 lists all the six items compared in Figure 4.

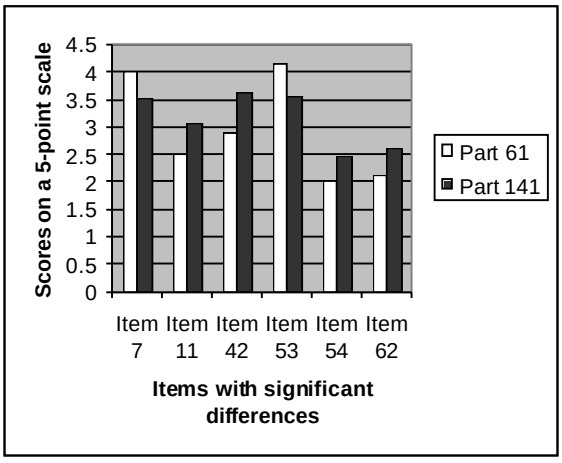

Figure 4: Level of agreement to items listed in table 1 below. All differences are significant, $p < 0.05$

Table 2: Table of items with significant differences across flight-training organizations.

Item Number	Description
7	The flight-training organization's rules should not be broken—even when the employee/student thinks that it is in the organization's best interest
11	I am ashamed when I make a mistake in front of my instructor or my peers.
42	I am trying to get through my flight training as fast as I can.
53	In my organization, deviations from published procedures are rare.
54	I am not comfortable reporting a safety violation because people in my organization would react negatively toward me.
62	Safety in this organization is largely due to the efforts of a few key individuals.

Analyses of the behavior survey, the FISSBQ Instrument

Since only one flight school volunteered to participate in the behavioral aspect of this study, this section of the paper is presented in the form of a case-study.

A study of private pilot behaviors at a flight training school. The subject flight-training school imparts instruction under 14CFR § 141. Out of the 44 respondents to the FISSBQ survey, 30 were private pilots, working toward their instrument rating. On an average, they had about 135 hours of flight time, 80% of them were male (11% were female, 9% undeclared), and they spent about 84 minutes on their preflight preparations for a cross-country flight.

In reviewing the procedural requirements of the school, it was noted that all the subjects (private pilots) were required to satisfy the following sequential requirements prior to receiving the key to their aircraft:

1. Each student is assigned a flight instructor. The student is required to get his/her cross-country flight route approved from that instructor. The school provides a list of approved cross-country airport pairs from which the student picks one suitable to his/her skill level and seeks his/her instructor's approval. When asked to indicate their level of agreement with the statement, "Before I go on cross-country flights, I always get my route approved by flight instructor," about 80 % of the respondents agreed or strongly agreed, about 7 % of them disagreed or strongly disagreed, and 13 % remained neutral.
2. Once the student selects which cross-country flight he/she wants to fly, he/she is required to complete several required flight log entries prior to seeking approval from the flight instructor. When asked to their level of agreement with the statement, "Before I ask for a sign-off on my planned cross-country route from my instructor, I always complete all the required flight log entries," about 80 % of the respondents agreed or strongly agreed, about 7 % of them disagreed, 2 % indicated that this requirement was not applicable, and 11 % of them remained neutral.
3. All students are required to obtain the Federal Aviation Administration's Direct User Access Terminal (DUAT) weather information in preparation for their weather briefing. When asked to their level of agreement with the statement, "I always use a current DUAT printout for my weather briefing," about 84 % of the respondents agreed or strongly agreed, about 7 % of them disagreed or strongly disagreed, and 9 % of them remained neutral.
4. Before asking for sign-off for the weather, the students are required to complete all the flight log entries. When asked to indicate their level of agreement with the statement,

"Before asking for a weather sign-off on my cross-country flights, I always complete my required flight log entries," about 80 % of them agreed or strongly agreed, about 9 % of them disagreed, about 9 % of them remained neutral and 2 % of them claimed that this requirement did not apply.

5. One of the most critical items in preflight inspection, is the engine oil level. Students are required to ensure that the engine contains at least 6 quarts of oil. When asked to indicate their level of agreement with the statement, "I have never departed on a cross-country flight with oil level below 6 quarts," about 89 % of them agreed or strongly agreed, about 8 % of them disagreed or strongly disagreed, and about 3 % of them remained neutral.
6. Next, students are required to carry full fuel on the first leg of their cross-country flights. When asked to indicate their level of agreement with the statement, "I have never departed on the first leg of my cross-country flight without full fuel," about 84 % of them agreed or strongly agreed, about 11 % of them disagreed or strongly disagreed, and 5 % of them remained neutral.
7. As they get ready to depart with the airplane, all the students are required to perform an engine run-up to validate its performance. When asked to indicate their level of agreement with the statement, "I have never departed on a cross-country flight without performing an engine run-up," about 93 % of them agreed or strongly agreed and about 7 % disagreed or strongly disagreed.
8. Within five minutes of departing from the airport, the students are required to open their flight plan. When asked to indicate their level of agreement with the statement, "I always open my cross-country flight plan within 5 minutes of departing from the airport," about 68 % of them agreed or strongly agreed, 11 % of them disagreed or strongly disagreed and 21 % of them remained neutral.
9. While on their cross-country flight, all students are required to keep-up with their navigational log entries. When asked to indicate their level of agreement with the statement, "I always complete the required navigational log entries while flying a cross-country flight," about 55 % of them agreed or strongly agreed, 27 % of them disagreed or strongly disagreed, and 18 % of them remained neutral.
10. Upon arriving at their destination, the students are required to close their flight plan. When asked about their level of agreement with the statement, "I always close my flight plan upon arrival at my first or second airport," about 90 % of them agreed or strongly agreed, 2 % of them disagreed, and about 8 % of them remained neutral.

When asked whether their flight school had sufficient checks and balances to ensure safety, about 89 % of them seemed to agree or strongly agree, 5 % of them seemed to disagree or strongly disagree, and 6 % of them remained neutral.

Discussion

With regard to the individual attitude items that differed significantly across the pilot groups, it is interesting to note that in this sample, student pilots were most embarrassed about their mistakes; private pilots were least interested in verbalizing the instructions that they received from their instructor; and commercial pilots believe that past accidents/incidents may not have led to safety improvements in their organization.

From an organizational perspective, it is interesting to note that flight-training organizations certificated under 14CFR § 61 seem to score higher on procedural compliance items. Considering that the 14CFR § 141 have much more structured federal requirements, one could conclude that because § 61 training schools do not have a stringent regulatory requirement, they have to have their own checks and balances. Consequently, they may tend to be more aware of the need to avoid uncertainty. On the other hand, the schools certificated under 14CFR § 141 seem to employ so much structure that the students may be intimidated by their rigid procedures. This may be one reason why such students are more reluctant to report any safety violations.

In the case-study presented in this paper about 80-90 % of the students tend to consistently comply with the procedural requirements. That means about 10-20 % of students are not consistent with their compliance. Yet when asked about the adequacy of the checks and balances in the operation procedures at the subject school, 89 % of the students agreed or strongly agreed, 4 % disagreed, 7 % remained neutral on the statement that their school's operating procedures had enough checks and balances.

Conclusions

It is clear that the limited sample size has made it unreasonable to apply the findings of this study to the target population--pilots in flights schools in the state of Missouri. However, the basic constructs regarding attitudinal measures and cultural factors remain of interest in the flight training community. Such research needs to be continued and additional flight schools need to involved so that the general aviation community will have a better understanding of the safety issues that have been studied in such great detail in the transport aviation environment. Furthermore, CRM- and MRM-type interventions that have been implemented in the transport aviation environment can be objectively evaluated for their suitability for the flight training environment.

Acknowledgments

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